Final Summary of ICCR Source Work Group Meeting
April 23-24, 1997
Stationary Combustion Turbine Work Group

I. Purpose

The main objectives of the meeting were to identify the goals, products, and schedule for each task group; assign task group leaders; discuss turbine operating practices which may result in HAP emissions reduction; discuss and identify potential unit modification on existing turbines which may increase turbine operating efficiency; identify questions/topics to ask turbine experts for the turbine technology workshop; and summarize the WG plan for the next six months.

II. Location and Date

The meeting was organized by Pacific Gas and Electric (PG&E) and was held at PG&E Office Building in San Francisco, California, located on 77 Beale Street. The meeting took place on April 23 and 24, 1997.

III. Attendees

Meeting attendees included representatives of the OAQPS Emission Standards Division, trade associations, and state agencies. A complete list of attendees, with their affiliations, is included as Attachment I.

IV. Summary of Meeting

The meeting consisted of discussions between WG members on selected issues which are listed below. The order of the meeting followed the agenda provided in Attachment II. A bullet point summary of the meeting is presented in Attachment III.

The topics of discussion included the following:

- Identification of Task Group Activities
- Examples of Previous MACT
- Contents of EPA Inventory Database
- HAP Emissions from Natural Gas Combustion
- Identification of Turbine Operating Practices and Efficiency Improvement
- HAP and Criteria Emissions as a Function of Turbine Operating Conditions

- Issues and Questions for the Turbine Experts
- Draft Work Group Work Plan

Identification of Task Group Activities

The first topic of discussion included presentations by each taskgroup regarding their goals, products, and scheduling. A total of five taskgroups were assigned, including EPA Database and Population Enhancement (Task Group 1), Subcategorization (Task Group 2), HAP Reduction Technologies, New and Existing (Task Group 3), HAPs vs. Criteria Pollutants (Task Group 4), and Testing and Monitoring (Task Group 5).

(I) EPA Database and Population Enhancement (Task Group 1)

The taskgroup leader of the EPA Database and population enhancement taskgroup (Task Group 1) is G. Adams. He indicated that the goals of this taskgroup are to:

1. Clean up the population database (remove non stationary combustion turbine records),
2. Summarize the information in the population database, and
3. Review the gathered HAP test reports for inclusion of turbine operating parameters.

G. Adams suggested that the population database verification process will include extracting a list of turbines which refer to owners and/or operators who are represented in the WG. The representatives in the WG will verify the information in the database as it applies to their facilities. They will review the information for its verification and completeness. G. Adams indicated that a large portion of the records in the database are unpopulated or null. He requested that the reviewers fill these information gaps as they see fit.

M. Schorr agreed with G. Adams, but suggested that the list of turbines should include manufacturers who are represented on the WG. In general, manufacturers of turbines are aware of the unique operating levels, scheduling, and parameters.

G. Adams also questioned the need for inclusion of all of the referenced information fields in the population database. He suggested that only a small portion of the information fields are necessary for the WG purposes. He indicated that one of the taskgroup tasks will be to summarize the information in the population database to include only the necessary information fields which are similar (with minor modifications) to the ones referenced in the “facility” table of the emissions database.

The WG also discussed the HAP emissions database. The WG concurred that the gathered source test reports should be reviewed by WG members for inclusion of turbine operating parameters during testing. Alpha-Gamma will distribute the gathered HAP source test reports among WG members for completion of this task.

S. Roy requested that any changes (as part of the WG verification process) should be conducted by a single contact or organization. The WG concurred with this issue and assigned Alpha-Gamma to be responsible for any modification to the database. S. Roy, G. Adams, and B. Richani will draft a protocol information modification for the WG approval. Alpha-Gamma will develop final protocol for all information modification.

The products of the database enhancement subgroup will include revised databases (population and inventory) and a set of summary tables of the gathered information. The tentative schedule on completing these deliverables is set for July to August, 1997.

(II) Subcategorization (Task Group 2)

M. Schorr is the taskgroup leader of the Subcategorization Task Group. He conducted a presentation explaining the reasons for subcategorization, how a subcategory is justified, identifying a preliminary list of potential subcategories, and providing an initial ranking of the identified subcategories. He concluded that these categories should be considered a “first cut” effort for subcategorization and should not be considered final. He also indicated that the WG needs to investigate these subcategories in more detail and should attempt to justify these subcategories with information from the population and emissions databases.

An initial report of potential subcategories will be submitted by M. Schorr during the upcoming WG May meeting. Tentatively, a memorandum depicting the final list of subcategories will be completed by September, 1997, subsequent to completion of Task Group 1 efforts. The presentation overheads presented by M. Schorr are included in Attachment IV.

(III) HAP Reduction Technologies, New and Existing (Task Group 3)

J. Klein is the Task Leader of Task Group 3. The group has prepared a presentation regarding new and existing HAP reduction technologies. Two types of HAP reduction technologies were discussed, including HAP reduction due to good operating practices, and HAP reduction due to the implementation of new and existing technologies. Taskgroup goals and scheduling were also presented. The taskgroup will document its findings in a written

memorandum of good operating practices by the upcoming WG May meeting. In addition, the subgroup will submit an intermediate report of new and existing HAP prevention or reduction technologies by September, 1997. The presentation overheads are included in Attachment V.

(IV) HAPs vs. Criteria Pollutants (Task Group 4)

C. Chang is the task leader for the HAPs vs. Criteria Pollutants Task Group. He conducted a presentation in which he provided a detailed discussion of a set of questions related to criteria pollutants, HAP pollutants, identification of the relationship of HAP vs. criteria pollutants, identification of turbine factors (operational and design) which directly affect HAP emissions, and the identification of potential surrogates for HAPs. He presented several graphs obtained from reciprocating internal combustion engines which reflected the relationship of criteria (specifically CO and VOC) emissions with respect to Air to Fuel (A/F) ratio for natural gas-fired engines. The objectives were to understand the emissions formation process and identify factors which may affect emissions levels. He indicated that the main product of the taskgroup will be documentation for turbines similar to the ones available for reciprocating internal combustion engines. The presentation overheads presented by C. Chang are included in Attachment VI.

In addition to identifying the behavior of HAP and criteria emissions due to combustion, the taskgroup will also investigate options for regulatory development. These options will include ammonia and PM_{25} emissions from turbines. The taskgroup will attempt to submit its findings by September, 1997.

(V) Testing and Monitoring (Task Group 5)

S. Roy is the Testing and Monitoring Task Group Leader. He discussed a preliminary cost estimate, which was drafted for EPA use comparing cost of FTIR test measurements vs. CARB test measurements. This preliminary test plan included a cost estimate for four subcategories, two types of fuels, and testing before and after existing control device. He indicated that for FTIR, the estimated cost was at one million dollars which was mostly attributed to performing precision validation for the tested pollutants. This is based on the assumption that one type of testing train covers all pollutants of interest. On the other hand, testing costs using CARB Methods was estimated at 750 thousand dollars. This corresponds to performing three CARB trains covering CARB Methods 410, 429, and 430 which should capture all pollutants of interest. S. Roy summarized a tentative testing plan for fiscal year 1997, indicating that since the performance of catalytic oxidizer controls have not been documented for HAPs, a screening study consisting of about three tests may be needed to determine control device efficiency and HAP emissions. The results of the screening tests will be used to help design the test plan for the combustion turbine workgroup. In addition, he indicated that the WG members need to identify a potential list of pollutants for which to test. The WG should

make use of the existing HAP emissions database available on the TTN to assist in identifying the potential list of pollutants.

Regarding test methods, S. Roy explained the interference with CARB Method 430 for formaldehyde emissions testing. He indicated that such an interference is only a concern on units with high levels of NO_X in the exhaust stream. To date, all evidence indicates that this is not applicable to gas turbines. The NO_X emission levels detected in the turbine exhaust stream are low enough that no interference is evident. He suggested that testing formaldehyde using the FTIR method may be an option in lieu of using CARB Method 430. R. Muller, however, indicated that he reviewed the applicability of the FTIR Method and concluded that it is not an efficient method and that it will take a long time to validate and apply. J. Klein also indicated that the California Air Resource Board is developing an option for CARB Method 430 regarding formaldehyde emissions testing.

The WG identified the need for monitoring the goals and progress of each taskgroup. The WG assigned S. Roy and M. Schorr to be the Planning Task Group, whose goal is to ensure and track progress of all taskgroups activities.

Examples of Previous MACT

S. Roy gave a mini-presentation on examples of previous MACT Developments. He identified the key parameters, such as “achievable” and “limitations”; types of MACT Floors including numerical (emission levels), technology based (control equipment), and operating practices; and differences between new source MACT vs. existing source MACT. S. Roy pointed out to the WG that there will be a detailed session during the CC meeting in July which will discuss MACT Development and provides examples of previous MACTs. This will be performed by OMB. He suggested that this topic be deferred until the next CC meeting. The WG concurred with this recommendation.

Contents of EPA Inventory Database

B. Richani made a presentation regarding the EPA population database. His presentation included a listing of the states which submitted electronic databases for inclusion in the EPA database, the revised database structure, identification of fields necessary in each table for unique record identification, an estimate of the total number of gas turbines captured in the database, and other database related items. The presentation overheads presented by B. Richani are included in Attachment VII.

Subsequent to presentations regarding the population

database, S. Roy provided the group with a brief summary regarding available market research databases for population information on gas turbine. He also discussed cost estimates of acquiring such databases. The consensus among the WG was to review the EPA population database prior to purchasing available market research databases.

HAP Emissions from Natural Gas Combustion

S. Roy discussed a study performed on process heaters firing natural gas. The study indicated that HAP emissions from Natural Gas (NG) combustion are minimal. This raised the issue of whether the standards development should exclude NG combustion. He also identified another study performed on utility sources firing NG. In both studies, it was determined that all pollutants resulting from NG combustion do not present a significant hazard to the public. These were the results on inhalation screening assessment for HAPs emitted from gas-fired utilities. Therefore, it should be determined whether the WG should make certain generalizations regarding NG combustion, and if so, what are the concerns or conflicts which may be identified. Several concerns were identified by the WG including:

(1) Oil production members will not be satisfied with a generalization that NG combustion emission are lower than fuel oil combustion emissions,

(2) Coal industry will not be satisfied that switching to NG will reduce emissions.

In conclusion, S. Roy indicated that there will be certain issues and conflicts which will need to be addressed if such a generalization regarding NG combustion is to be made. He recommended that any member of the WG who is aware of other study reflecting similar conclusions for NG combustion should forward it to EPA for review. This concluded the first day’s meeting.

The objective outlined on the second day meeting were to discuss turbine operating practices, potential efficiency increase methods, techniques, and discuss the issues and questions to ask turbine experts in the upcoming Turbine Technology Workshop scheduled in July, 1997.

Identification of Turbine Operating Practices and Efficiency Improvement

J. Klein led a discussion on turbine operating practices which may result in HAP emission reduction. The applicability of such practices to standard development were also discussed. A

concern pointed out by the WG was that it is not feasible to set or identify certain operating practices as regulatory standards. These practices are site and application specific; therefore, they should be identified as guidance rather than potential regulatory standards. The WG concurred that it is very difficult to identify typical operating practices as regulatory standards, specially for gas turbines. These unit may not operate properly if the operating practices are not followed according to manufacturer's recommendations. J. Klein's discussion also included identification of the potential modifications which increase operating efficiency, discussion of the feasibility of such modifications on existing units, and prediction of the effect of such modifications on HAP emissions.

The WG came to consensus that it is important to identify and discuss the applicability of good operating practices and efficiency improvement to regulatory development. This reflects the WG's efforts in identifying potential control techniques.

Ideas and concerns were identified regarding turbine operating practices and efficiency improvements. Each idea was clearly defined with its pros, cons, and qualifications. The WG identified a total of seven operating practices and three efficiency improvement practices. These ideas are presented in Attachment VIII. Task Group 3 members will be summarizing all identified ideas by May 23, 1997.

HAP and Criteria Emissions as a Function of Turbine Operating Conditions

C. Chang discussed how HAP and Criteria emissions behave as a function of turbine operating conditions. His presentation covered questions related to potential emissions vs. Air-to-fuel ratio, combustor design, steam or water injection, etc. The questions presented by C. Chang are listed in Appendix IX.

Issues and Questions for the Turbine Experts

J. Klein and C. Brown lead a discussion regarding the issues and questions to ask the turbine experts during the upcoming Turbine Technology Workshop. Included in the discussion were the goals, timing, format, and outcome of the workshop. The workshop topics discussed are presented in Appendix X.

The WG selected the keeper of the technology workshop questions to be members of Task Group 3. All questions will be identified and submitted to the workshop presenters by mid May, 1997. The WG decided to include the following topics to the technology workshop:

(1) Firing temperature vs. residence time relationship to HAP formation,

(2) New generation turbines vs. old generation turbines,

(3) Synthesis vs. burnout of HAPs,

(4) Combustor configuration vs. potential HAPs,

(5) Turbine size vs. HAPs formation,

(6) Turbine firing fuel vs. HAPs formation,

(7) Turbine load vs. HAP formation,

(8) Turbine inlet temperature vs. HAP formation, and

(9) Duct burner vs. HAP formation.

Draft Work Group Work Plan

In concluding the meeting B. Richani gave a quick overview of the goals, schedules, and products identified for each taskgroup. This summary was gathered from the presentations material conducted by each taskgroup during the first day meeting. Each taskgroup will review the summaries put together by B. Richani and finalize them prior to the next WG meeting. The summaries presented are included in Attachment XI.

The WG meeting was adjourned around 1 pm.

These minutes represent an accurate description of matters discussed and conclusions reached and include a copy of all reports received, issued, or approved at the April 23, 1997 meeting of the Stationary Combustion Turbine Work Group.

Sims Roy

ATTACHMENT I

LIST OF ATTENDEES

Stationary Combustion Turbine Work Group Meeting
April 23 and 24, 1997
List of Attendees

Sims Roy	EPA OAQPS Emissions Standards Division
Greg Adams	Los Angeles County Sanitation District
Sam Allen	Dow Chemical Company
Charles Chang	LA Dept. Of Water and Power
A. J. Cherian	Pacific Gas Transmission Company
Ted Guth	Permitting Regulatory Affairs Consultant
Peter Hill	US Naval Facilities Engineering Svc. Center
John Klein	ARCO Alaska, Inc.
Marvin Schorr	Power Systems Engineering Department
Pete Roberts	Solar Turbines
Gordon Brown	Exxon Chemical
Jim Greer for Jorge Torres	Natural Gas Pipeline of America
Linda Coerr	Coerr Environmental
Pamela Lacey	American Gas Association
Chuck Solt	Catalytica
Randy Poteet	ARCO Alaska
Jim Pfeiffer	Anchorage Municipal Light and Power
Derek Furstenwerth	Houston Lighting and Power
Virginia Gorsevski	Environmental Protection Agency
Adriane Borgias	Pacific Gas Transmission Company
April Gordon	Pacific Gas and Electric Company
Paul Chu	Electric Power Research Institute

Brahim Richani Alpha-Gamma Technologies

ATTACHMENT II

April 23 and 24, 1997 MEETING AGENDA

AGENDA
STATIONARY COMBUSTION TURBINE WORK GROUP
APRIL 23 and 24, 1997, Meeting in San Francisco, CA
Pacific Gas and Electric (PG&E) Office at 77 Beale St. Rm 304, 305

APRIL 23, 1997

8:30 - 8:40 am	WELCOME
8:40 - 10:00 am	Task Groups Activities (goals, products, and scheduling) - Task Group 1 (EPA Database and Population Enhancement, Greg Adams) - Task Group 2 (List of Subcategories, Marvin Schorr)
10:00 - 10:15 am	BREAK
10:15 - 12:15 am	Task Groups Activities (Cont.) - Task Group 3 (HAP Reduction Technologies, New and Existing, John Klein) - Task Group 4 (HAPs Vs. Criteria Pollutants, Charles Chang) - Task Group 5 (Source Tests, Raimund Muller)
12:15 - 1:30 pm	LUNCH
1:30 - 2:15 pm	Examples of Previous MACT Developments (Sims Roy)
2:15 - 3:15 pm	Inventory Databases - Contents of EPA Database (Brahim Richani) - Available Commercial Databases (Sims Roy)
3:15 - 3:30 pm	BREAK
3:30 - 4:15 pm	Testing Needs - DQO process for FTIR and use of CARB Method 430 (Sims Roy) - Estimated testing needs (cost) for FY 97 (Sims Roy)
4:15 - 4:45 pm	HAP Emissions from Gas-Fired Combustion Issue (Sims Roy)
4:45 - 5:15 pm	Compose the Meeting Flash Minutes
5:15 pm	ADJOURN

APRIL 24, 1997

8:30 - 9:30 am	Turbine Operating Practices - Identify operating practices which may result in HAP emissions reduction - Discuss the applicability of such practices to existing units
9:30 - 10:15 am	Turbine Efficiency Increase - Identify the potential modifications which increase turbine operating efficiency - Discuss the feasibility of these modifications on existing units - How does this affect HAP emissions?
10:15 - 10:30 am	BREAK
10:30 - 11:15 am	HAP Control and Prevention Techniques (John Klein)
11:15 - 12:00 noon	Issues and Questions to Ask Turbine Experts (John Klein)
12:00 - 1:15 pm	LUNCH
1:15 - 3:00 pm	Detailed Discussion of Specific Task Group Topics
3:00 - 3:15 pm	BREAK
3:15 - 3:30 pm	Summarize Work Group Work Plan for the next six months
3:30 - 3:45pm	Compose the Meeting Flash Minutes
3:45 pm	ADJOURN

ATTACHMENT III

BULLET POINT SUMMARY

Summary of ICCR Source Workgroup Meeting, April 23-24, 1997.
Stationary Combustion Turbine Workgroup
PG&E, San Francisco, CA

Decisions

- S. Roy and M. Schorr are part of the planning task group whose goal is to ensure and track progress of all task groups' activities.
- WG members should review the HAP emission source test reports for inclusion of operating parameters..
- The WG will attempt to complete its review of the databases (population and HAP emission tests) within 3-4 months.
- S. Roy and B. Richani will develop a protocol of how to update and modify the information in the databases (both the EPA CT population and emissions databases). They will be the keepers of the databases and responsible for any information updates.
- S. Roy will be the task leader on Task 5 (source tests).
- Need to identify combustion experts who may be able to provide an explanation for the formation of the identified HAPs; submit names to S. Roy.
- Prior to identifying the testing needs for existing turbines, the WG will need to wait until data gaps are identified in the EPA database.
- WG agreed on the goals and scheduling of the HAP Technology Workshop.
- Questions for the Technology Workshop should be submitted to J. Klein by May 9, 1997.
- WG agreed on the goals, products, and scheduling for all task groups.

Next Meeting

- Next meeting will be a teleconference on Tuesday, May 13, 1997, from 1:00 to 3:00 p.m. EST. The call-in number is 919-541-4485.
- Agenda will include preparing a WG status report for the Coordinating Committee.

Action Items

- G. Adams will:
  - Develop a revised list of the fields from the facility table in the emissions database to be used for population;
  - Break out EPA database information corresponding to the facilities which are represented by WG members; and
  - Develop a checklist of items to be reviewed.

  These items are scheduled to be completed by May 22, 1997.
- B. Richani will provide hard copies of all HAP test reports for the WG members by May 12, 1997.
- S. Roy will summarize the concentrations for HAPs gathered in the test report and circulate it to the WG by May 15.
- S. Roy will develop a goal statement, products to be produced, and schedule for the Testing and Monitoring Task Group by May 15, 1997.
- T. Guth and S. Roy will develop a WG status report to present at the CC by May 9, 1997.
- P. Chu will work with C. Chang on obtaining information on utility industry risk assessment study to submit to S. Roy.
- C. Solt will provide documentation of CO as a surrogate for HAP/hydrocarbons emissions.
- J. Klein will prepare a letter which will list the preparations expected for the Technology Workshop presenters (i.e., open discussion, agenda, handouts, etc.) by mid-May, 1997.
- The HAP reduction task group will submit the list of questions for the Technology Workshop to the presenter by mid-May, 1997.
- R. Muller will coordinate with ICAC equipment manufacturers who are interested in participating in the Technology Workshop in Los Angeles in July, 1997.
- J. Klein will offer an invitation to trade associations to participate in

the Technology Workshop.

- M. Schorr and C. Solt will coordinate with the Legislative and Regulatory Affairs Committee of ASME, IGTI (International Gas Turbine Institute) and GTA (Gas Turbine Association) regarding their participation in the Technology Workshop by May 15, 1997.

ATTACHMENT IV

SUBCATEGORIZATION PRESENTATION

GAS TURBINE CATEGORIZATION

WHY CATEGORIZE ??

1. To consider development of separate regulations for each category, or

2. To eliminate some categories from regulation

GAS TURBINE CATEGORIZATION

Can We Justify ANY Subcategorization ???

There Should be Something Unique Enough About a Subcategory That it Would Need Separate Consideration in a Regulation, or it Might Need Separate Regulation For Cost/Economic Reasons -

Sims Roy - EPA Guidance

GAS TURBINE CATEGORIZATION

Age
Size
Fuel
Combustor Type
Firing Temperature
Annual Hours of Operation
Add-on Emission Control
Use/Application
Configuration
Mobility
Cycle

GAS TURBINE CATEGORIZATION

Age - Pre-NSPS before 1979, NSPS 1979 - 1990, Post-NSPS after 1990
Size - < 1 MW, 1-10 MW, 10-30 MW, >30 MW
Fuel-natgas, distillate, byproduct gas, syngas, crude, heavy oil, methanol
Combustor Type- can, silo, annular-all diffusion flame or staged premix
Firing Temperature - <1800^{o}F, 1800-2020^{o}F, 2020-2350^{o}F, >2350^{o}F
Configuration - SC, CC, regen/recup, mechanical drive
Add-on Control - injection, SCR, CO catalyst, catalytic combustor
Use/Application - utility (base, mid, peaking), IPP, cogen, pipeline
Cycle - Brayton, Recuperative, Kalina
Annual Hours of Use - < 500, 500-1500, 1500-3500, > 3500 hours
Mobility - portable, stationary

GAS TURBINE CATEGORIZATION

The following 3 categories are considered first order:

Size - < 1 MW, 1-20 MW, >20 MW
(2 instead of 1?, 17 instead of 20 MW?, 30 instead of 20?)
Fuel - gases, liquids, syngas
(should landfill/biogenic gases be included?)
Firing Temperature - <1800°F, 1800-2350°F, >2350°F
(Is residence time/more, or as important?)

May also want to consider the following:

Cycle - Brayton, Recuperative, Kalina
Mobility - portable, stationary
Other - duct burners

GAS TURBINE CATEGORIZATION

Categories initially eliminated (may want to revisit some):

Age - related to firing temperature; whether unit started operation under NSPS or other criteria pollutant regs
Combustor Type - residence time probably the key; hard to define type
Configuration - considered second order
Add-on Controls - use only as related to firing temperature (steam/water injection) since that increases CO (and possibly HAPS)
Use/Application - size related - small units used in different applications than big units

ATTACHMENT V

HAP REDUCTION TECHNOLOGIES PRESENTATION

HAP Reduction Technologies
New and Existing

Sam Allen
Gordon Brown
A.J. Cherian
John Klein
Raimund Muller
Sims Roy
Chuck Solt

HAP Reduction Technologies

Identify Good Operational Practices

Investigate Technologies for HAP Prevention or Reduction for New and Existing Sources

Identify Good Operational Practices

Goal - Written document which supports committee recommendations.

Tasks:
- Discussion on 4/24/97
- Literature Search, Expert Input if needed
- Report Writing (Draft by 9/1/97)
- Committee Review / Acceptance

Investigate Technologies for HAP Prevention or Reduction for New and Existing Sources

Goal - Written document which supports committee recommendations.

Tasks:
- Efficiency Imp. Discussion on 4/24/97
- Lab Scale Testing - Englehardt
- Technology Workshop on 7/25/97
- Literature Search
- Recommend Tests to Fill Data Gaps

Investigate Technologies for HAP Prevention or Reduction for New and Existing Sources

Tasks (continued)
- Intermediate Report by 9/1/97
- Committee Review / Acceptance
- Final Report

Operational Practices

Roundtable discussion

List the following for each idea:
- Description of Operational Practice
- Pros: Potential for HAPs Reduct./Prevent.
- Cons: Negative impacts
- Qualifications: What is basis?
  - -HAPS Data
  - -CO/HC Data
  - -Engineering Judgment

Operational Practices - Ideas

Gas Fuel Conditioning
Monitoring/Maintaining proper gas superheat and liquids removal

Load Management
Running most efficient machines - avoiding lightly loaded operation of machines

Monitoring EGT Deviation
Attending to fuel maldistribution problems

Operational Practices

Summarize Discussion

Decide Actions Required to Close Topic

Assignments as necessary

Efficiency Improvement - Ideas

Convert to Gas Fuel

Addition of Regenerator

Turbine Mod’s (for Mature Models)
- Extra Compressor Stage
- Firing Temperature Increase
- Leakage Reduction
- Aerodynamic

Efficiency Improvements

Summarize Discussion

Decide Actions Required to Close Topic

Assignments as Necessary

ATTACHMENT VI

HAPs vs. CRITERIA POLLUTANTS PRESENTATION

HAP VS CRITERIA POLLUTANT

Before NO_x control, no CO problem. Why ?

complete combustion:
plenty of air & high temperature

Typical NO_x vs VOC & CO relationship

NO_x controls became requirements in 1970s.

NO_x Control Techniques Reduce air to fuel ratio. Lower peak flame temperature.

As a result, NO_x concentration came down but VOC & CO concentration went up.

Noticing the higher CO concentration level, regulators began to limit CO concentration.

As the NO_x control rules became more stringent, SI was combined w/combustion modification.

As NO_x is lowered, no VOC & CO increase at first.

As NO_x is reduced further, VOC & CO starts to creep up.

As NO_x is lowered even more, both VOC & CO climbs up rapidly.

At some point, it is not worth-while to trade incremental NO_x reduction w/VOC & CO increase.

There is a linkage between NSPS & MACT.

The early dry low NO_x burners have CO concentration above 100 ppm.

More recent NO_x control technologies (1990s) based on advanced dry low NO_x burners and catalytic combustion have low NO_x and CO concentration.(A CO oxidation catalyst is not needed.)

NO_x vs NH_3

NH_3 is not one of HAP.

Section 112 defines MACT in consideration of <u>environmental</u> and other impacts.

NO_x & NH_3 reacts to form nitrates, a $PM_{2.5}$.

NSCR and SCR NO_x control technologies inject NH_3 to react with NO_x.

Because of sub 10 ppm NOx control requirements, NH_3 is over injected.

As a result, unused NH_3 escapes (about 10 to 20 ppm).

By backing off slightly on NO_x control requirement, much NH_3 emissions can be prevented.

Questions:

How does VOC & CO behave as a function of NO_x control for GTs?

Do HAPs follow VOC concentration?

What are the types of GT burners?

How does GT manufacturers set air to fuel ratio? Can the ratio be reprogrammed?

Can steam or water injection rate be reprogrammed to optimize NO_x with HAPs?

States can establish more stringent regulations than EPA. If desired, can EPA tell the states not to adopt or even back off from the stringent NO_x rules for GTs so that HAP emissions are prevented and CO catalysts are unnecessary?

ATTACHMENT VII

EPA INVENTORY DATABASE PRESENTATION

EPA ICCR DATABASE
Stationary Combustion Turbine
April 23, 1997
ICCR Database - CTs

Merged/Replaced State Information Obtained state electronic databases from 18 States:

Illinois (Merge)	Michigan (Merge)
Maine (Merge)	New York (Merge)
Ohio (Merge)	Vermont (Merge)
Wisconsin (Merge)	Washington (Merge)
Missouri (Merge)	West NorthCarolina(Merge)
Virginia(Merge)	
California (Replace)	Texas (Replace)
Tennessee (Replace)	Florida (Replace)
New Jersey (Replace)	Pennsylvania (Replace & Merge)

Several States did not Submit their Database

Utah
Louisiana

The Database does not Include Databases Gathered from Local Agencies

Gathered information from over 10 Local Agencies

No Additional Efforts will be Conducted on Gathering these Databases

Each WG May Decide to Perform this Task, as Needed

Complexities

Plant identification number not consistent with the AIRS/OTAG PNED format
Missing segment number
Missing SCC Code

Revised Existing Tables

Accommodate state information
Accommodate the EPA ICR for Incinerators and Boilers burning non-fossil fuel

After Gathering State Information:

Captured information for 5,435 turbines
Identified 62 records to correspond to reciprocating engines

ICCR Facility ID

ICCR Facility ID= [State Code] + [County Code] + [PNED ID]
- State Code is 2-Digits long
- County Code is 3-Digits long
- PNED ID is 4-Digits long
- ICCR Facility ID is 9-Digits long

Combustor ID

Combustor ID is assigned by the facility or state and can be as long as 5-Digits long
ICCR Facility ID and Combustor ID provides a unique identification of a combustion unit

Segment No.

Segment No is assigned by the facility or state and can be as long as 4-Digits long
It is an identification of the operation method of the combustion unit (fuel type, operating schedule, etc., note: SCC is linked to the segment level)

List of Tasks to be Performed

Clean up the database
- Identify duplicates
- Review for obvious misfits (Identify units which are not turbines)
- Delete all parameters without a unit of measure

Extract Useful Information, such as, Turbine Size, Make, and Model
- Review the Combustor Description field
- Review the Fuel Flowrate field

List of Tasks to be Performed (cont.)

Determine turbine population distribution
- Convert all unit sizes into a consistent unit of measure (I.e., MW or HP)

Identify Preliminary Subcategories

Develop Model Plants
- Fuel type
- Unit capacity (range)
- Control device information

Validation of the Information

DOE EIA Form 860
- Electric Utilities in the US, for 1995 Data 1058 Turbines

DOE EIA Form 867

DOE UARG

EPA 1992 Section 114 Questionnaire

IPP & Industrial	1,556 Turbines
Pipeline	1,000 Turbines
Utility Companies	1,496 Turbines

Market Research Sources

PowerData Group	2,502 Turbines (plus 1,000 to 3,000 not yet entered)

WG Members and Associations
- GE, AGA , API, & INGAA

ATTACHMENT VIII

OPERATIBG PRACTICES and EFFICIENCY IMPROVEMENTS IDEAS

Operation Practices

Idea 1: Monitoring and Maintaining Gas Preheat (Fuel Pretreatment, Filtering and/or Refrigeration for Digester Gas, not Natural Gas.

Pros:
1. Eliminate Liquid Droplet (Heavy HC)
2. Common Practices (Manufacture Specific for Premix)

Cons:
1. Not Applicable to all Turbines (e.g. Diesel Fuel)
2. How to Measure Compliance
3. Other Business Drivers

Qualifications: No data, concern about shutdown of fuel pretreatment to even schedule testing clog fuel injectors and potentially damage combustor liner.

Operation Practices (Cont.)

Idea 2: Monitor Air to Fuel Ratio (in local Flame Zone).

Pros:
1. Potential for Lean Premix Type

Cons:
1. How does one monitor, Require Design Change/algorithms Program (Operator can't Change the set A/f or algorithms)

Qualification:

Operation Practices (Cont.)

Idea 3: Monitor Steam (Water) to Fuel Ratio

Pros:
1. Often Required in Air Permit

Cons:
1. Require Re-Permitting if Different than Current Permit (CO limit) Higher Steam Rates get More Power Resulting in More HAPs

2. Cost of Water or Steam (Tradeoff with Power Production)

3. Increases No_x if reduce Steam to Fuel

Qualification: CO Data Maybe/NO HAP Data

Operation Practices (Cont.)

Idea 4: Monitor/Control NH_3 to No_x

Pros: 1. Minimize $PM_{2.5}$ from NH_3 Nitrate/Sulfate Formation Downwind.

2. Proposed NAAQS

Cons: 1. NH_3 is not CAA HAP (not Prime Consideration)

2. No Current NH_3 Monitoring, but Permit Limit in Many Permits

Qualifications:

Operation Practices (Cont.)

Idea 5: Load Management and Avoid Lightly Load Machines

Pros: 1. Reduce HAP/CO at Higher Load

2. Reduce Fuel Consumption (Economic)

Cons: 1. Not Available to Most Operators (Only multiple Turbine Site

2. Isolated Operator (Platforms) Concern about Reliability

3. Different for Load Following Units (Pipelines)

4. Difficult to Regulate Common Sense

Qualification:

Operation Practices (Cont.)

Idea 6: Monitoring Exhaust Gas Temperature Deviation (Thermocouples)

Pros: 1. Done According to Manufacturer recommendations

Cons: 1. Only Read Average in many Turbines

Qualification:

Operation Practices (Cont.)

Idea 7: Operator Training

Pros: 1. Done in other Areas (e.g. MWC, CEMs)
Ex. Appendix F (40 CFR Part 60)

Cons: 1. How to Link to Reduced Emissions

2. Minimal Operator Involvement for Remote Units

3. MWC Case Dependent or Variability; Not the Case for Gas Turbines

4. Minimal “Knobs” to Operate. Automatic Controls

Qualification:

Efficiency Improvements

Idea 1: Upgrade/Update Mature Models

Pros: 1. May Offer Additional Power

2. Reduction Potential for CO/HAPs

Cons: 1. Hours of Operation May Not Justify Expense (<200 Hours)

2. Current Permit Limits/Constraints

3. Increase No_x

4. Reduce Fuel May Not Improve Air

5. May Require New Source and Repermitting/Trigger NSR (Reconstruction/Modification)

Qualification:

Efficiency Improvements (Cont.)

Idea 2: Adding a Generator

Pros: 1. Lower Fuel Input Requirement HAPs Implications

Cons: 1. Only Applicable to Low Pressure Machines, Do Not Benefit High Pressure Ration Machines

2. Configuration Constraints
3. Potential for Higher No_x

4. Leakage/Maintenance Pollutants

5. Capital Cost

6. Space Constraints

7. Reduce Power Output

Qualification:

Efficiency Improvements (Cont.)

Idea 3: Convert to Gas Fuel

Pros: 1.

Cons: 1.

Qualification: Efficiency Implications. Only Minor Benefits for its Application.

APPENDIX IX

HAPs and CRITERIA EMISSIONS BEHAVIOR PRESENTATION

Questions:

Do NO_x, VOC, & CO behave as a function of air-to-fuel ratio in GTs as they do in boilers and ICEs? What do the concentration vs. Air-to-fuel ratio curves look like?

Questions (Cont.):

Do HAPs follow VOC concentration? What does a HAP vs. air-to-fuel curve look like? Does individual curves differ from one another?

Questions (Cont.):

What are the types of GT burners? What are their respective guarantees for emissions?

How do GT manufacturers set the air-to-fuel ratio? Can the ratio be reprogrammed?

Questions (Cont.):

What is the air-to-fuel ratio that optimizes emissions of HAP, VOC, NO_x, & CO?

Questions (Cont.):

Hoe do HAP, VOC, CO & NOx vs SI rate curves look like for GTs?

Can steam or water injection rate be adjusted to optimize NOx with HAPs, CO, & HC? If so, what is the optimum fuel-to-steam ratio?

Questions (Cont.):

What do NO_x & NH_3 concentration curves look like as a function of NOx-to-NH3 mole ratio?

What is the optimum NOx-to-NH3 mole ratio that will minimize both NO_x and NH_3 emissions?

Questions (Cont.):

States can establish more stringent regulations than EPA. If desired, can EPA tell the states not to adopt or even back off from the stringent NO_x rules for GTs so that HAP emissions are prevented and CO catalysts are unnecessary?

Products

A set of questions for the panelist.

Source testing reports.
HAP vs criteria pollutant curves as a function of fuel-to-air ratio

HAP vs criteria pollutant curves as a function of steam injection rate

NO_x vs NH_3 curves as a function of NH3 to NOx ratio

Surrogate indicator for HAP

Status report on HAP vs criteria pollutant trade off

Recommendations

APPENDIX X

HAPs TECHNOLOGY WORKSHOP PRESENTATION

HAPs Tech. Workshop Goals:

Identifying possible HAPs control and Prevention techniques (which currently exist / commercially available) for new and existing Gas Turbine Sources
Time and Place:

July 25, 1997 in Orange County

Workshop Format

(Tentative)
Panel Discussion ~ 30 Minutes each Presenter

4 Presentations AM, 3 Presentations PM
End of Day - Wrap up Session Summarize Common Threads

Identify Take Away Messages

Discuss Follow on work needs

Workshop Presenters

Academia / Combustion Expertise

Dr. Scott Samuelsen, Dr. Randy Seeker, Don Bahr

Turbine Manufacturer?

Equipment Manufacturers, Catalytica

Research Organizations

Workshop Topics (1)

The control of CO/HC in gas turbine combustors and relationship to HAPs Effectiveness of the latest generation of lean pre-mixed combustors in reducing NOx while minimizing impact on CO/HAPs Use of TBC coatings or ceramics in combustors to control CO/HAPs

Workshop Topics (2)

Use of modulating IGV's at part load to control CO/HAPs Catalytic Combustion for HAPs Control Relationship between HAPs and CO Understanding the tradeoffs between criteria

pollutants and HAPs Relationships between Operations practices and HAPs

Workshop Topics (3)

Potential for Fuel Pretreatment in HAPs Control Exhaust Gas Controls - Catalysts Availability of HAPs Data - (or lack of) Etc.

ATTACHMENT XI

WORK GROUP WORK PLAN

Combustion Turbine Work Group Work Plan
for the Next Six Months

April 24, 1997

CT WG Work Plan
Task Group 1, Database Enhancement

Goals:

Clean up the population database
Summarize the information in the population database
Review the gathered HAP test reports

Products:
Revised (QA/QC) databases (population & Emissions)
A set of summary tables/reports of the gathered information

Schedule:
July to August, '97

Task Group 2, Subcategories

Goals:
Identify potential subcategories
Minimize applicable subcategories based on the gathered information

Products:
Summarize and write up the selected subcategories in a memorandum

Schedule:
Memorandum of potential subcategories - May meeting

Memorandum of final subcategories subsequent to completion of Task Group 1 efforts - August to September, '97

Task Group 3, HAP Reduction Technologies

Goals:
Identify good operation practices
Investigate technologies for HAP prevention or reduction for new and existing sources

Products:

Identify good operating practices, including efficiency improvements
Identify HAP prevention or reduction technologies

Schedule:
Written Memorandum of good operating practices - May meeting
Intermediate report of HAP prevention or reduction technologies - September 1, '97

Task Group 4, HAPs Vs. Criteria Pollutants

Goals:
Identify the relationship of HAPs Vs. Criteria emissions
Identify the turbine factors (operational and design) which directly affect HAP emissions

Products:
Documentation similar to the one available for IC-Engines but generated from turbine data
Identification of options for Regulatory development

Schedule:
Written document - August to September, '97

Task Group 5, Testing and Monitoring

Goals:
Identification of potential HAPs emitted from turbines
Drafting of a testing protocol for HAP emission testing and control device efficiency determination

Products:
A condensed list of potential HAPs
Report documenting control efficiencies of selected add-on controls
Estimate of testing budget needs

Schedule:
List of HAPs - May meeting

Screening Study Test Plan - Aug to Sep, 1997

Screening Tests (if funds are available) - Nov, 1997

Combustion Turbine Test Plan - Dec, 1997

Control device testing and efficiency documentation - Subsequent to the CC allocation of testing budget. WG is ready to test existing sources, if permission is granted